# An End-to-End Modeling and Simulation Testbed (EMAST) to Support Detailed Quantitative Evaluations of GIG Transport Services

**14 June 2005**

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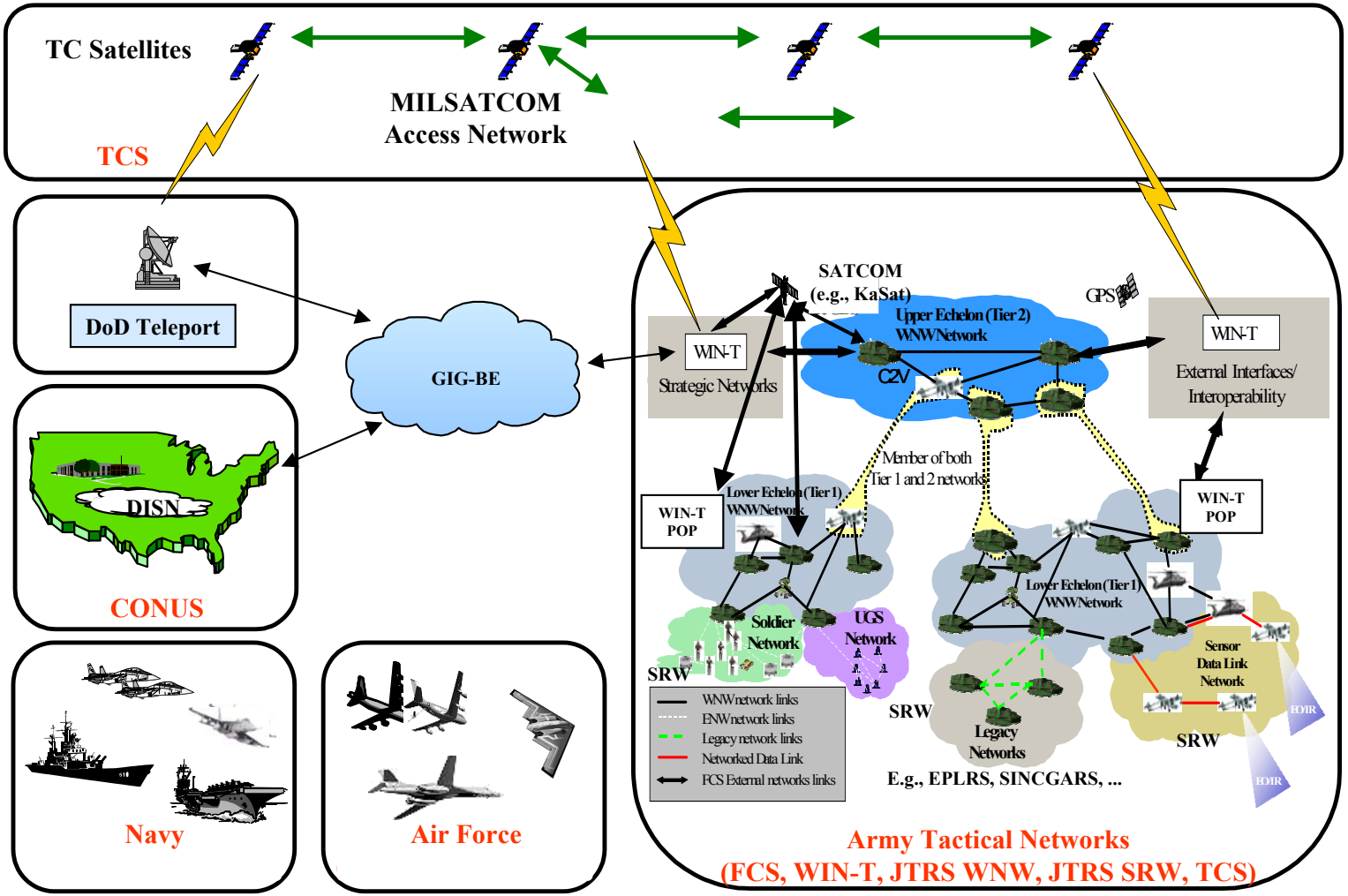
# Objective: Evaluate Various Aspects of End-to-End Communications via M&S





# Technical Approach

- Extend the Modeling and Simulation Environment (MSE) developed by MITRE over the past several years in support of the JTRS and DARPA FCS-C programs
  - Single radio device type in a MANET wireless environment
  - Representative operational scenarios
  - Accounts for terrain-induced path attenuation
  - Supports reproducibility and re-use of models and scenarios
- Develop an End-to-End M&S Testbed (EMAST) having the same capabilities as the MSE plus ability to support:
  - Multiple radio device types (e.g., WNW & SRW)
  - Multiple networks (e.g., JTRS & WIN-T)
  - Heterogeneous networks (i.e., wired and wireless)

# What Is An M&S Environment?

- **For our purposes …..**

M&S Environment = "simulation kernel" + "stuff"

  - **The "stuff" includes middleware to support such things as:**
    - **Scenario generation**
    - **File manipulation and format translation**
    - **Enhanced data collection**
    - **External (a priori) processing**
  - **It may also include other COTS tools**

**In our case, the "simulation kernel" is OPNET and the "stuff" includes all of the above**

# M&S Environment (MSE) Overview
## (Being used to support JTRS WNW)

Key:
- Developed by MITRE
- Provided to Contractor
- Provided to Gov't

Path attenuation data for each node pair as fcn(time), accounting for both terrain and foliage

Contractor-Developed Comms Technology

INTEGRATE

Node Laydown, Mobility, Traffic Profile

Binary File

Pathloss.c

<scenarioname>_path_loss.gdf

OPNET

I/F

Global Mgr
Thread Mgr
OE
CE-AL
OpFac

COMTEST

SDF, PDEF, & MDEF Files

SDF Parser

<scenarioname>.devices
<scenarioname>.ef
<scenarioname>.em.c
<scenarioname>.thproc.gdf
<scenarioname>.thsched.gdf
<scenarioname>.trj files

**Performance Data**

<scenarioname>_seed_xxx_OE_OUT.txt
<scenarioname>_seed_xxx_TM_OUT.txt
<scenarioname>_seed_xxx_summary_OUT.txt

# M&S Enviro

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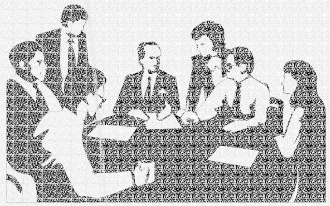

Node Laydown, Mobility, Traffic Profile

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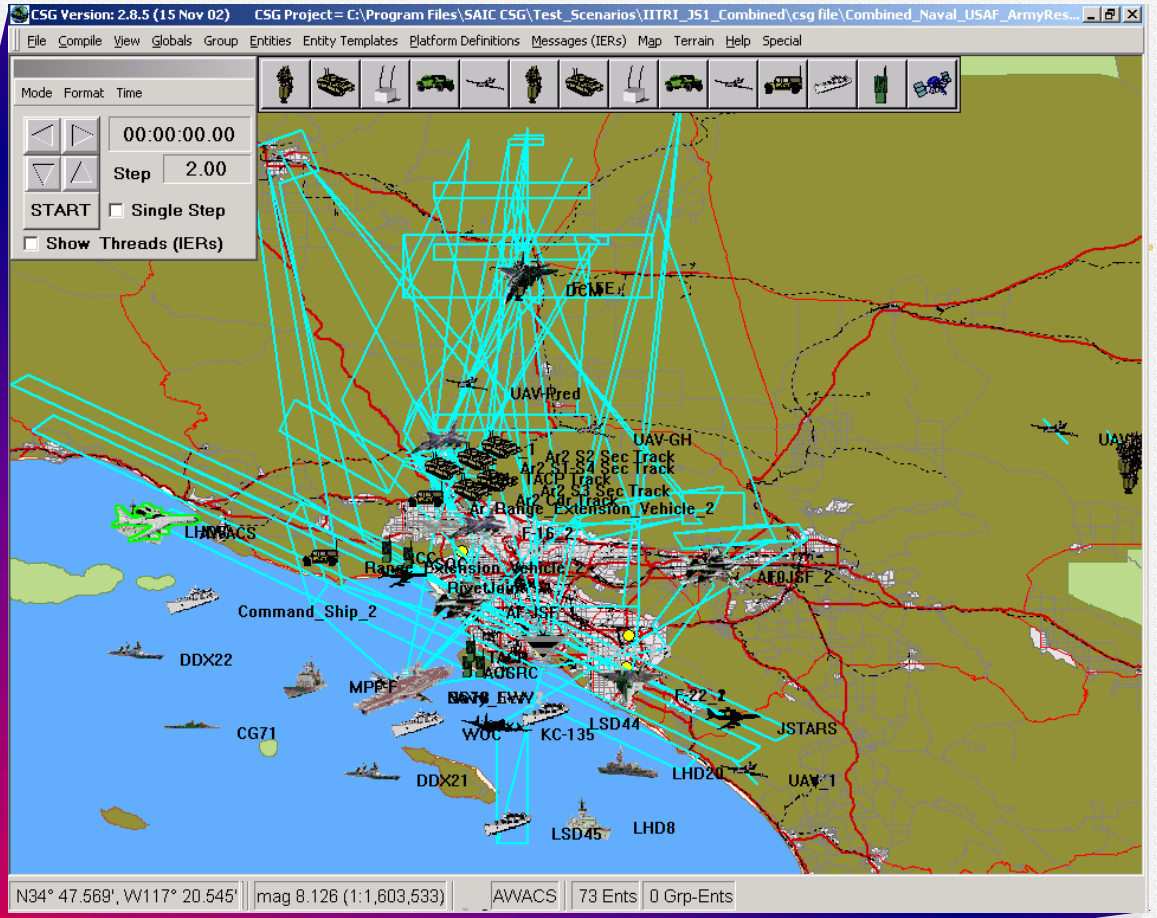


COMTEST

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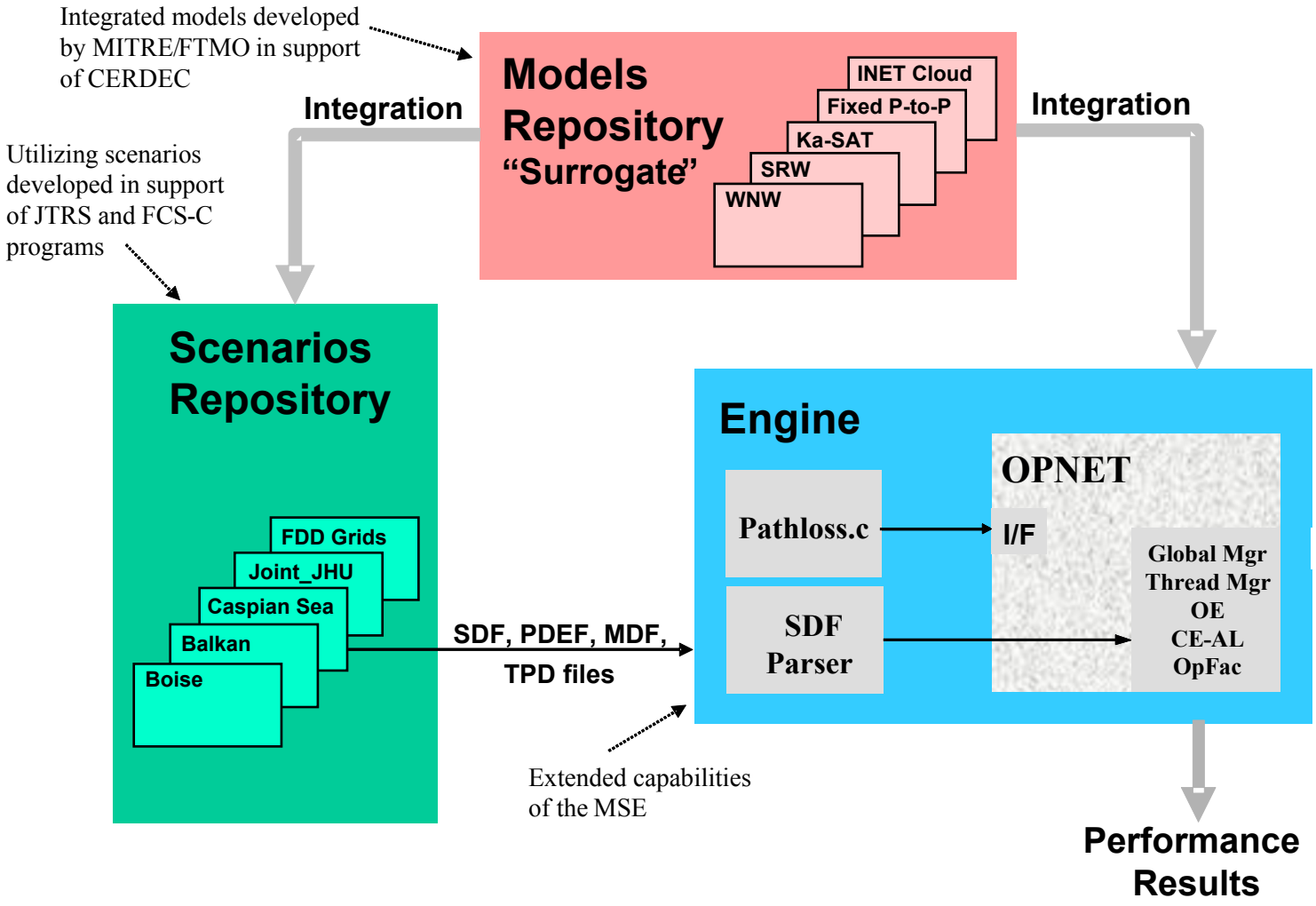
# EMAST – Phase I

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# EMAST Capabilities

## Phase I (Sept '04)

- 10 to ~100 nodes
- Heterogeneous (wired & wireless) networks
- Multiple radios devices
- Operational scenarios
- Static and mobile ground-based, air-based, and satellite-based nodes
- OPNET-based version 9.1
- Multicast traffic via flooding
- Transport – TCP or UDP
- Stryker Force scenario

## Phase II (Sept '05)

- >100 nodes
- OPNET-based version 10.5
- Multicast traffic via PIM-SM
- Integrate PEP/SCPS models
- Support QoS (limited DiffServ)
- Support HAIPE (Spec vs2)
- Additional scenarios and analyses

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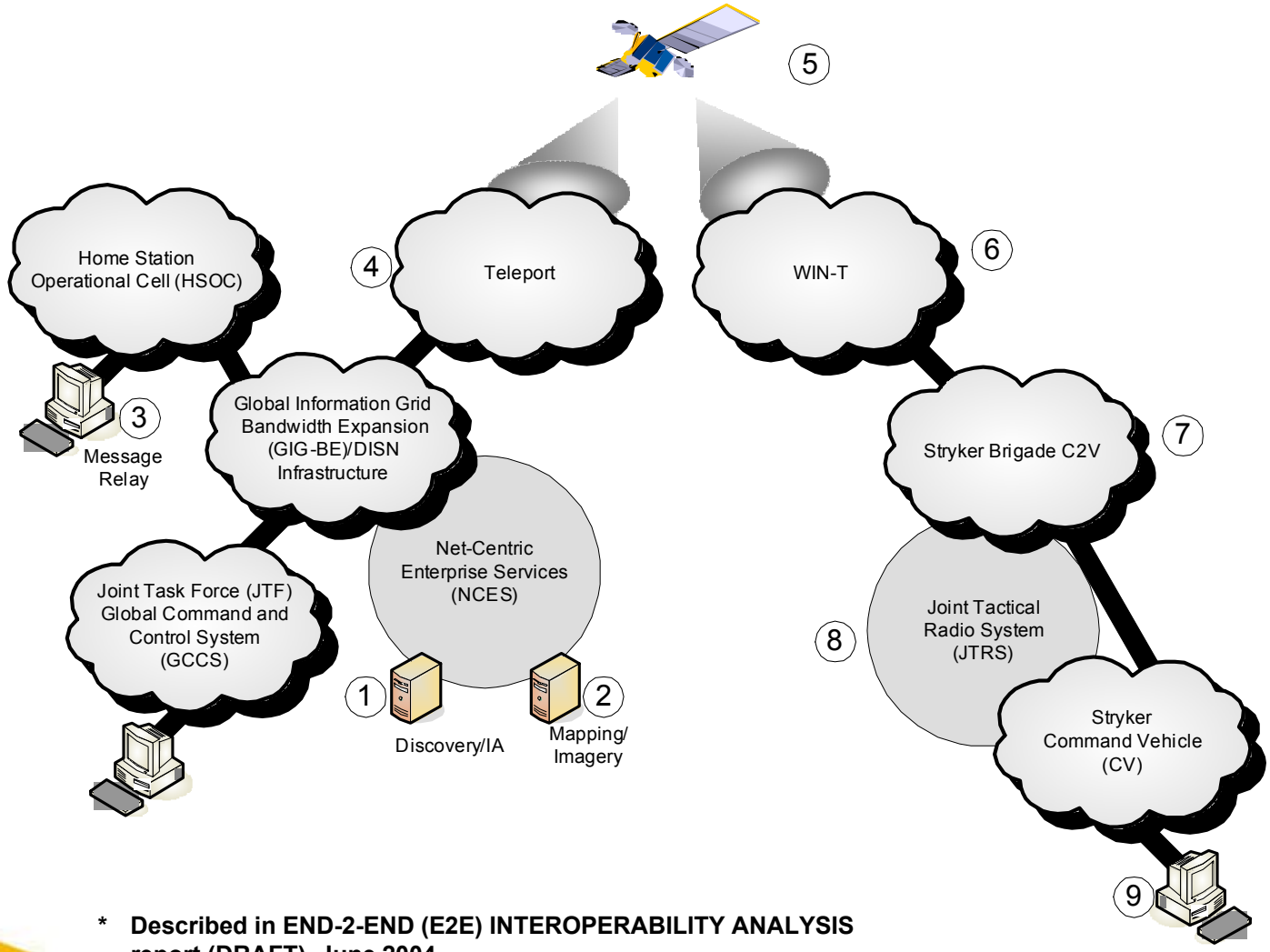
# What Can We Do With EMAST?

- Investigate the performance capabilities and/or impact of any comms network technology that can be modeled in OPNET
- Measures of performance include
  - E/E delay
  - Throughput
  - Completion rate
  - All on a packet, IER or Thread basis
- Example investigations
  - Modulation/coding and antenna design alternatives
  - TDMA vs CSMA MAC layer design alternatives
  - Unicast/multicast routing protocol design alternatives
  - Impact of different transport mechanisms (TCP, UDP, SCPS, etc. and combinations)
  - Impact of alternative QoS mechanisms or HAIPE

# EMAST Proof-of-Concept (POC) Study

- Purpose
  - To validate the functionality of the EMAST Phase I capability
  - To demonstrate the use of the EMAST Phase I capability within the context of a "realistic" application
    - Leverage END-2-END (E2E) INTEROPERABILITY ANALYSIS report (DRAFT), June 2004 in defining study scenario
      - Focus on the transport service

# Key GiG Systems Involved in Stryker Brigade Thread*




* **Described in END-2-END (E2E) INTEROPERABILITY ANALYSIS report (DRAFT), June 2004**

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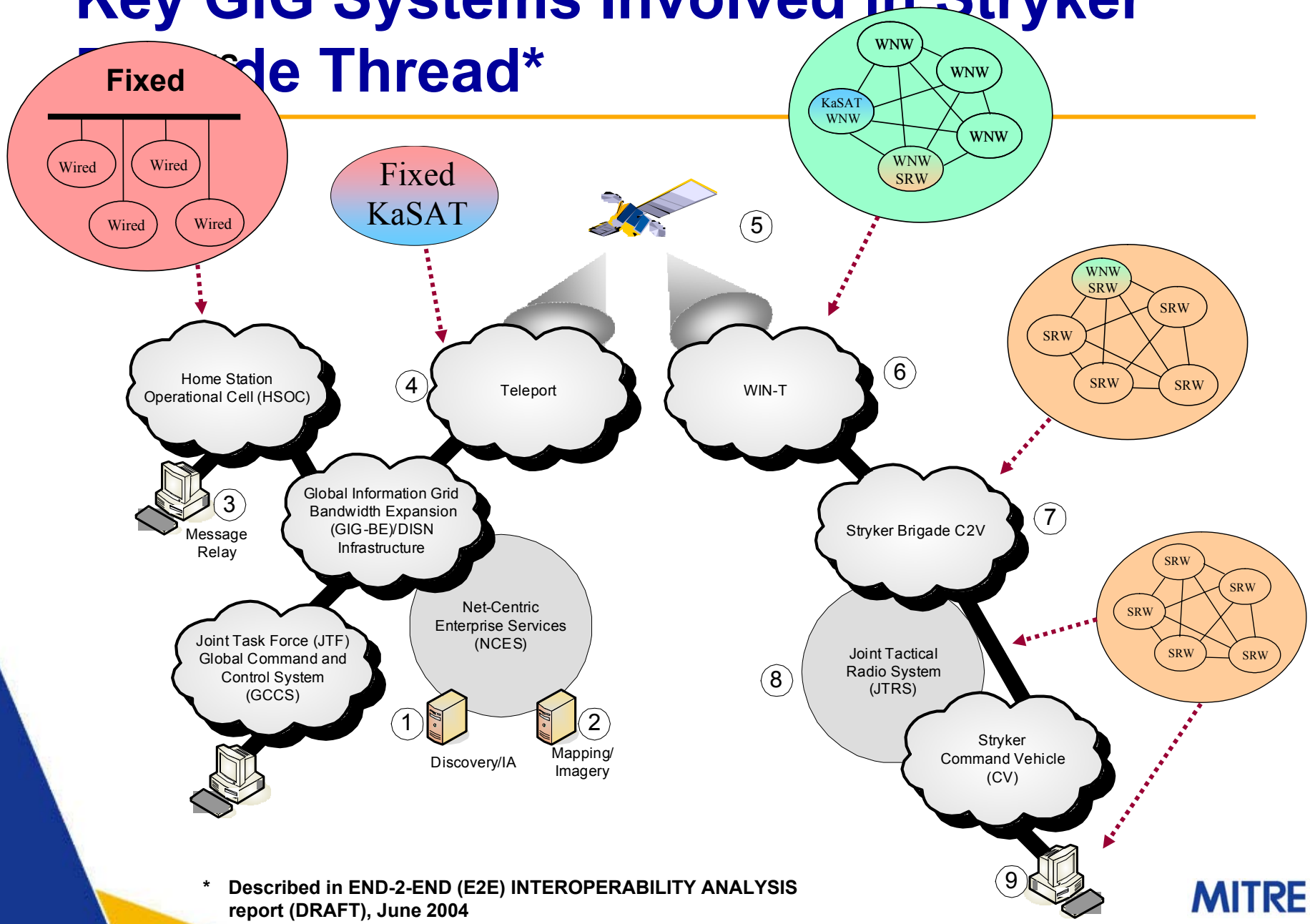


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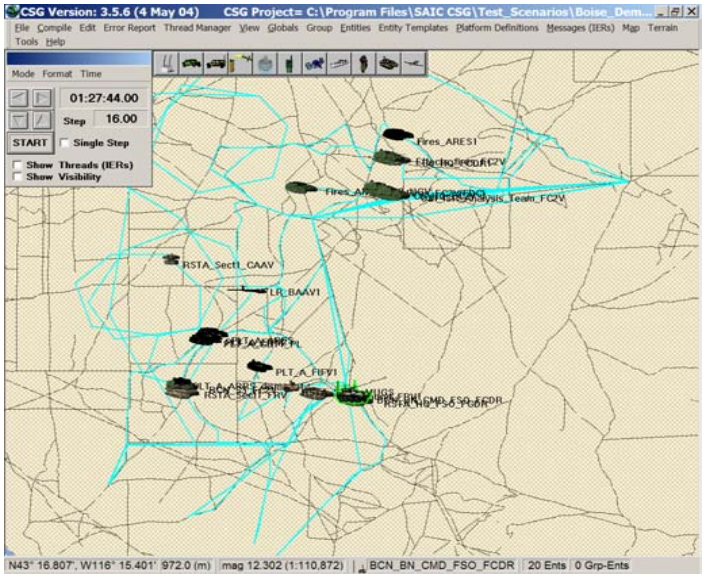
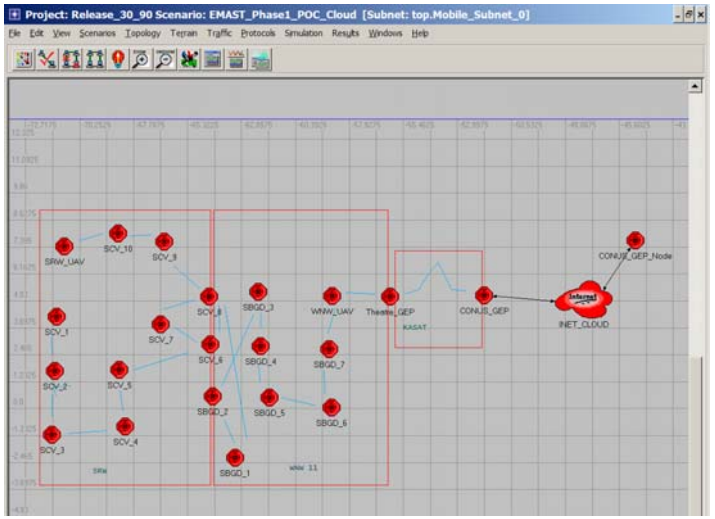
# EMAST Phase I Stryker Force Scenario

- Modify "Boise" scenario developed in support of FCS-C program
  - 21 nodes
  - Mobility
  - Terrain-induced LOS blockage
  - Add Washington DC "CONUS" component and internet "cloud"
  - Unicast & Multicast traffic
  - Data, voice, video, and multimedia traffic




COMTEST




OPNET

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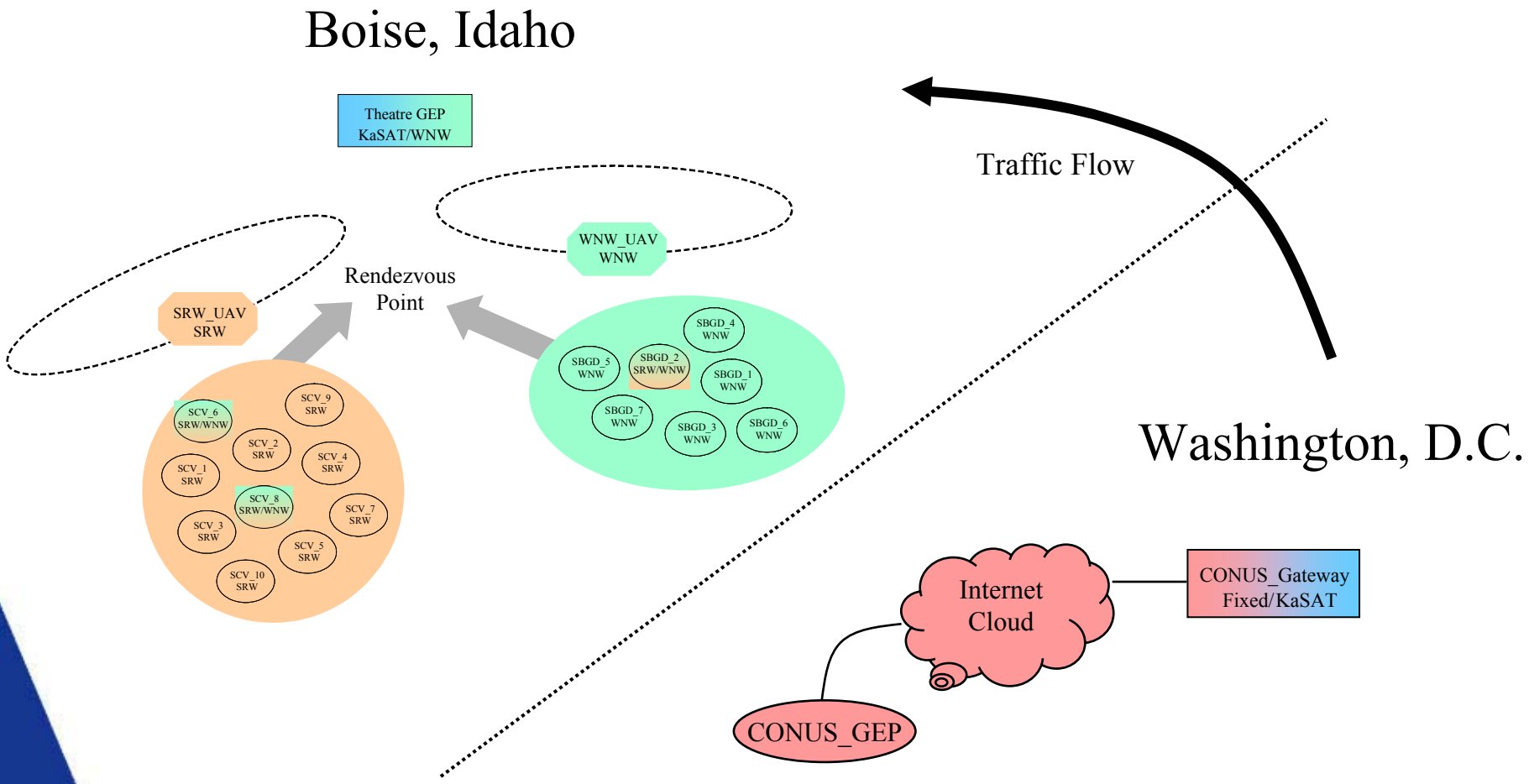
# EMAST Phase I Stryker Force Scenario
## (Concluded)




Leverage FCS-C Demo 3 Boise Scenario

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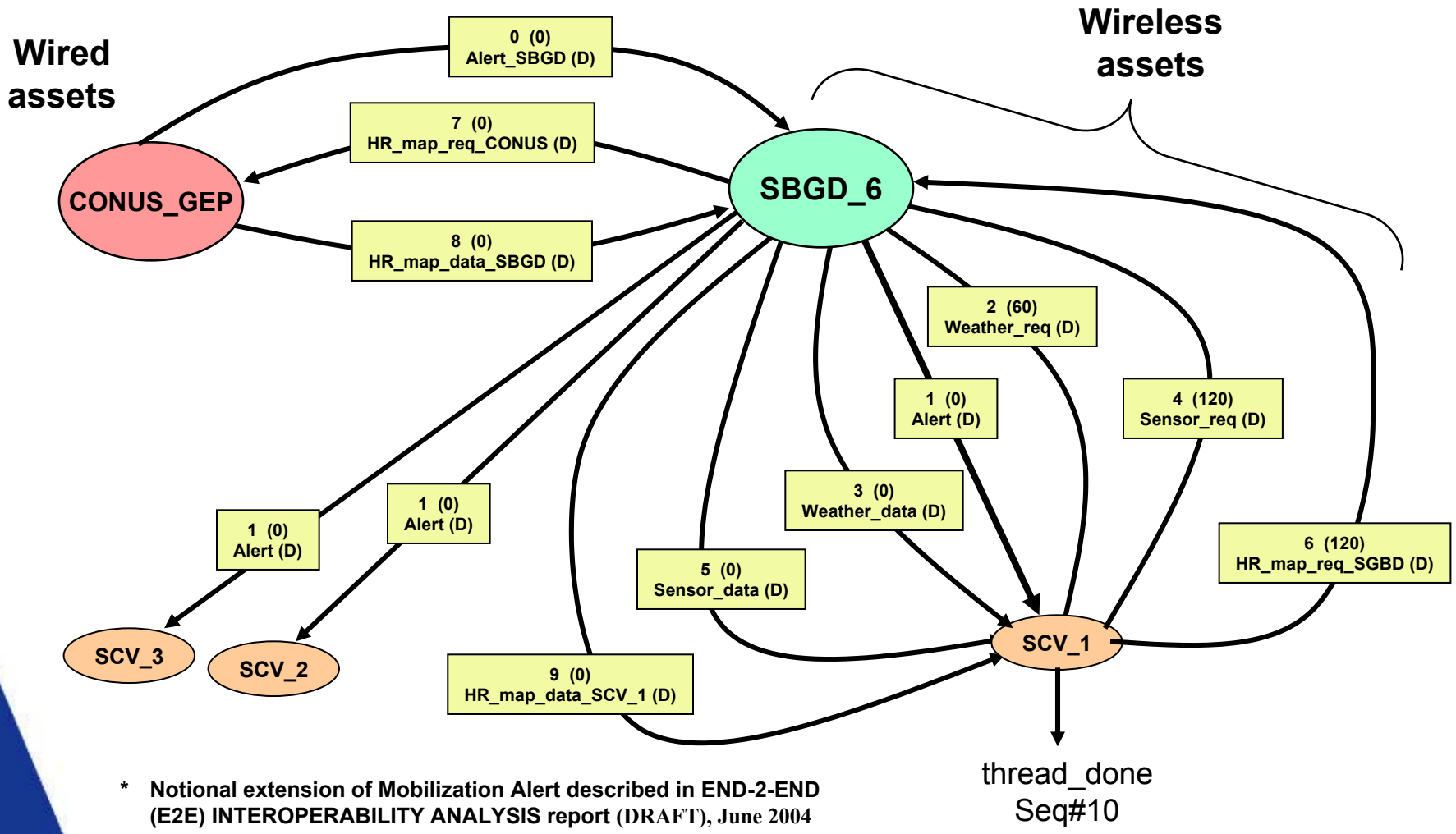
# Proof of Concept Study Thread*

**SATCOM**




* Notional extension of Mobilization Alert described in END-2-END (E2E) INTEROPERABILITY ANALYSIS report (DRAFT), June 2004

SCV: Stryker Command Vehicle
SBGD: Stryker Brigade HQ

"req" IERs are 8kbytes; all others are 100 kbytes

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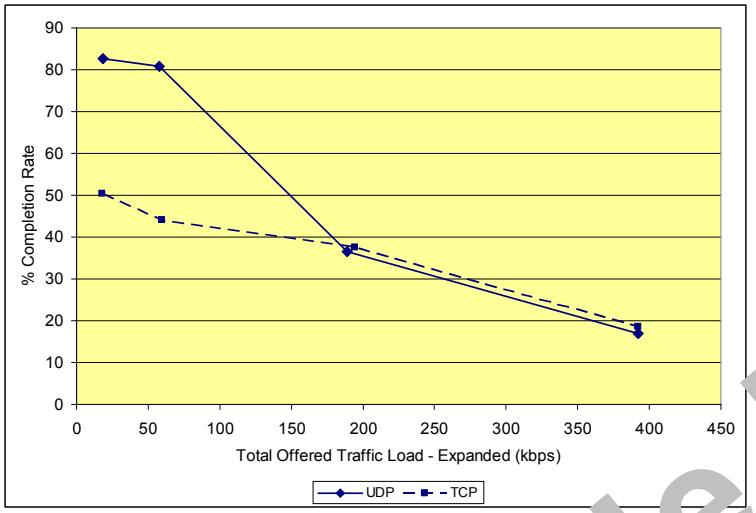
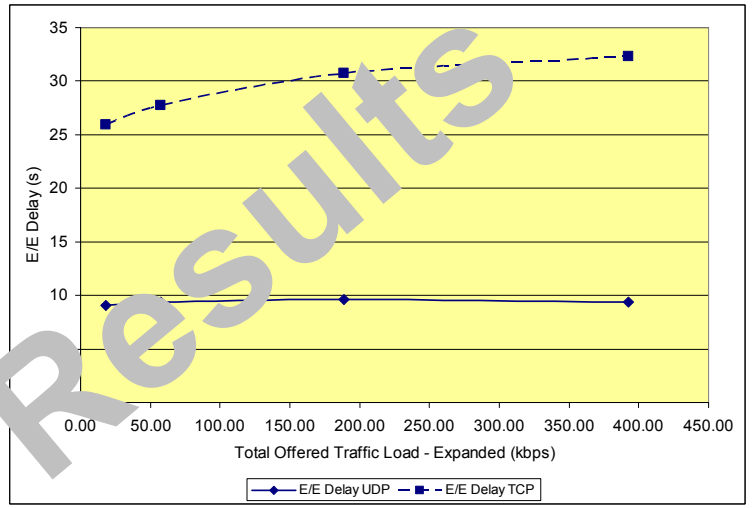
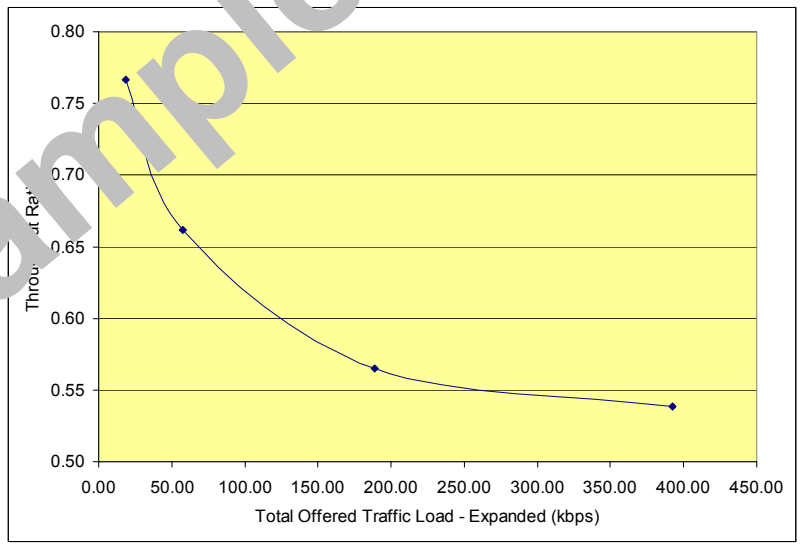
# EMAST Phase I Stryker Force Analysis
## (% Completion Rate, E/E Delay, Throughput Ratio)





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# EMAST Status

- EMAST Phase I completed 30 Sept 04
- Proof-of-Concept Analysis completed 30 Nov 04
- On schedule to complete Phase II by 30 Sept 05
  - >100 nodes
  - OPNET-based version 10.5
  - Multicast traffic via PIM-SM
  - Integrate PEP/SCPS models
  - Support QoS (limited DiffServ)
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  - Additional scenarios and analyses